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A Multi-Criteria Decision Making Approach for Analysing Prospective University Students Course Selection Decision Problem in Nigeria

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ABSTRACT

Prospective university students at the end of the senior secondary school education find it challenging to choose the most suitable course to be studied at the university level. The difficulty may be attributed to numerous alternatives courses available for students to choose from while considering diverse conflicting decision attributes. This paper presents a VIKOR methodology for ease of course selection for prospective university students. The suitability of the proposed technique is illustrated with an example of a student having a challenge in selecting the best course from among medicine, engineering, and law while considering four decision criteria as the basis for evaluating the performances of each alternative course. The proposed technique was validated by comparing it with an approach used in the literature in solving a related course selection decision problem. The proposed methodology although easier in terms of computation yet produces the same result as the method in the literature. The VIKOR approach is therefore a feasible alternative for dealing with the problem of course selection for prospective university students.

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1. INTRODUCTION

Choosing the best undergraduate degree programme for prospective university students is a difficult task because the decision-making process involves numerous course alternatives with several different decision criteria (Aziken et al., 2021). The students in this category are those who have completed their senior secondary school education having written and passed the senior secondary school certificate examination. In Nigeria, students in this category are prospective university students whose average ages generally range from 15 to 18 years. Concerning the course selection problem for prospective university students, the

alternatives could be the various undergraduate degree programmes such as Bachelor of Engineering degree in diverse Engineering field, Bachelor of Science degree in the diverse science field and Bachelor of Art in the various art field. The alternatives can also be the different options in these various fields available for the prospective university students to choose from. For example, in the Engineering field, the students may be faced with the challenge of choosing the best alternative from Civil, Mechanical, Chemical, Petroleum, Marine, and Electrical Engineering. The decision criteria generally include student interest, course duration, tuition fee, and employment opportunity (career prospect) among others (Lokare and Jadhav 2016).

The multi-criteria decision making (MCDM) techniques are of different types with the commonly used ones including vlsekriterijumska optimizacija ikompromisno resenje (VIKOR), elimination and et choice translating reality (ELECTRE), technique for order preference by similarity to an ideal solution (TOPSIS), preference ranking organisation method for enrichment evaluations (PROMETHEE), and analytical hierarchy process (AHP). The tools have been applied in making decision in diverse fields especially when the decision makers are faced with complex decision problems consisting of multiple options and numerous decision attributes. Emovon et al. (2016) applied the combination of the multi-attribute utility theory (MAUT) and ELECTRE method to estimate the optimum interval for carrying out maintenance inspection of a marine diesel engine. Dev et al. (2020) used the VIKOR method to analyse the optimum material for the piston of an automotive. Ilangkumaran, et al. (2013) utilized the PROMETHEE technique to prioritize alternative materials for the bumper of an automobile. The AHP technique was applied by Uğur and Baykan, (2017) to solve the problem of wall material selection. The MCDM tools have also been applied in the selection of the best course from among alternative courses for prospective university students. Lokare and Jadhav (2016) used the TOPSIS model to evaluate prospective university student course selection problem. The TOPSIS method was also utilized by Nanayakkara et al. (2019) to solve the course selection problem for prospective university students. From the literature, it is obvious that very limited work has been carried out on course selection for prospective university students and to bridge the gap in the literature and further, aid these set of students to make the appropriate decision for their future career development there is the need to explore more MCDM approaches. The tool simultaneously evaluates the performance of diverse alternatives against different decision criteria to select the best option. Therefore, this study aimed at investigating the application of the VIKOR method in analysing prospective university student course selection problem.

2. METHODOLOGY

2.1. VIKOR Method

The VIKOR techniques calculation phases are as follows (Opricovic, and Tzeng, 2004; Chang and Hsu., 2009):

If there are *m* course alternatives represented as Aj = A1, A2…Am, and *n* number of decision criteria indicated as Ci =C1, C2…Cn. The course selection problem can be represented in the form of matrix as follows:

$$E_{ij} = \begin{bmatrix} e_{11} & e_{12} & \cdots & e_{1n} \\ e_{21} & e_{22} & \cdots & e_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ e_{m1} & e_{m2} & \cdots & e_{mn} \end{bmatrix} \quad (1)$$

Where e_{ij} is the course alternative, Aj, rating against criterion Ci

In this phase, the best e_i^* and worst e_i^- values are determined for each criterion and if the criterion is beneficial the evaluation is carried out as follows:

$$e_i^* = \max_j \left(e_{ij}\right) \quad (2)$$

$$e_i^- = \min_j \left(e_{ij}\right) \quad (3)$$

Where e_i^* is best value of each criterion function and e_i^- is best value of each criterion function

The utility measure (Xj), is evaluated in this phase for each course alternative as follow:

$$X_j = \sum_{i=1}^{n} w_i \left(e_i^* - e_{ij}\right)/(e_i^* - e_i^-) \quad (4)$$

According to Chatterjee and Chakraborty (2016), Equation 4 is applied when decision criteria are beneficial while the term $e_i^* - e_{ij}$ in Equation 4 is replaced with $e_{ij} - e_i^-$ when decision criteria are non-beneficial.

The regret measure, (Yj) is evaluated in this phase for each course alternative as follow:

$$Y_j = \max_i \left[w_i \left(e_i^* - e_{ij}\right)/(e_i^* - e_i^-)\right] \quad (5)$$

Where w_i are the criteria weights.

The VIKOR index (Q_j), for indicating the performance of each course alternative is defined as:

$$Q_j = v\left(X_j - X^+\right)/(X^- - X^+) + (1-v)\left(Y_j - Y^+\right)/(Y^- - Y^+) \quad (6)$$

Where: $X^+ = \min_j\left(X_j\right)$; $X^- = \max_j(X)$; $Y^+ = \min_j\left(Y_j\right)$; $Y^- = \max_j\left(Y_j\right)$ and v define the decision-making strategy of the maximum group utility weight. The value of 0.5 is generally assigned to *v*.

The course alternatives are ranked with respect to their VIKOR performance index Q value and the best rank is the one having the smallest value.

2.2. Implementation

To demonstrate the suitability of the VIKOR technique in analysing the problem of course selection, a case of prospective university student course selection decision problem was used. The prospective university student will have to identify the potential courses he or she intends to study at the university level. In this paper, the potential courses identified by the student are medicine, engineering, and law. To choose the most appropriate course from among the three alternatives, their performance was evaluated with respect to four decision criteria (student interest, (C1), employment opportunity (C2), course duration (C3), and tuition fee (C4)). The decision criteria were adopted from the work of (Lokare and Jadhav 2016) and are described as follows:

Student interest: The degree of interest students has for different courses varies. Some students have more preference for science-based courses such as engineering and medicines while others have more preference for art-based courses such as law. To assign a rating to interest, a scale of 1 to 5 was applied. A rating of 1 is assigned to interest if the student is having no interest in a particular course and 5 if there is high interest in the course.

Employment opportunity: Different courses have diverse degrees of employment opportunity. Some have low employment opportunities while others have high employment opportunities. In this study, a scale of 1 to 5 was used in assigning a rating to courses with the one having the lowest employment opportunity being assigned 1% and the one with the highest employment opportunity being assigned 5%.

Course duration: The duration, of course, is an important criterion for students in determining the course most appropriate for them to study at the university. Most students prefer courses with a short duration. Ratings are assigned based on the number of years available to study the course. For example, students spend four years studying accountancy in Nigeria, and in rating accountancy four is assign.

Tuition fee: Tuition fees per session for different courses differ. Tuition fees for some courses such as medicine are high while tuition fees for some other courses are relatively low. In this paper, ratings were assigned based on fees paid per annum in naira.

The student has to assign a score to the three alternative courses against the four decision criteria to form the decision problem matrix. Ratings assigned by the student for each course against decision criteria are indicated in Table 1. The decision criteria weights in Table 1 were adapted from the work of Lokare and Jadhav (2016) for ease of comparison of the proposed VIKOR method with the TOPSIS approach applied by them.

Table 1: Course selection decision matrix for prospective university student

Alternative courses	C1	C2	C3	C4
A1	5	5	6	161500
A2	3	3	5	124000
A3	1	3	5	129000
Criteria weights	0.19	0.64	0.07	0.07

The decision problem in Table 1 was analysed using the VIKOR method to determine the best course for the prospective university student. The process starts with the determination of the best and worst values for each criterion applying Equations 2 and 3 respectively to data in Table 1. Xj and Yj were then evaluated using Equations 4 and 5. The overall performance (Qj) of each alternative course was evaluated by applying Equation 6. The course alternatives were ranked with respect to the Qj values with the one having the lowest Q value being the best solution.

To validate the proposed methodology (VIKOR method) for managing prospective university course selection decision problem, the method was used to solve a case of high school student course selection problem in India previously solved by Lokare and Jadhav (2016) using the TOPSIS approach. The course selection problem consists of four alternative courses: Bachelor of commerce (A1), Chartered Accountancy (A2), Bachelor of Business Studies (A3), and Bachelor of Management Studies (A4). The high school student is to choose the best course to study at the university from among A1, A2, A3, and A4 while utilising C1, C2, C3, and C4 to determine the performance of each alternative course. The decision matrix for the problem is presented in Table 2.

Table 2: Decision matrix for high school student course selection problem in India (Lokare and Jadhav, 2016)

Alternative courses	C1	C2	C3	C4
A1	6	70	3	2000
A2	9	95	5	2000
A3	8	85	3	3000
A4	5	85	3	3000
Criteria weights	0.19	0.64	0.07	0.07

The result obtained using the proposed VIKOR method in solving the problem was then compared with the result obtained by Lokare and Jadhav (2016) using the TOPSIS method.

3. RESULTS AND DISCUSSION

The VIKOR method Xj, Yj, and Qj values of prospective university student alternative courses are presented in Table 3. From Table 3, the most appropriate subject for the prospective university student is medicine (A1) having the lowest Qj value of 0.00 while the least suitable course for the student is law (A3) having the highest Qj value of 1.

Table 3: Xj, Yj, and Qj values and rank of alternative courses selection for prospective university student

	A1	A2	A3
Xj	0.1400	0.7350	0.8393
Yj	0.0700	0.6400	0.6400
Qj	0.0000	0.9254	1.0000
Rank	1	2	3

The comparative study results indicating the rank order of alternative courses of a high school student in India obtained using the VIKOR and TOPSIS methods are presented in Table 4. The comparative study was carried out to validate the proposed VIKOR method.

Table 4: Comparison of the proposed method with the TOPSIS method

Alternatives	VIKOR method Rank	TOPSIS method Rank
A1	4	4
A2	1	1
A3	2	2
A4	3	3

From Table 4, both the proposed method (VIKOR method) and the TOPSIS method utilized by Lokare and Jadhav (2016) produced a descending ranking order of A2, A3, A4, and A1 for the four alternative courses. The best course for the high student is Chartered Accountancy (A2). The rank order of the remaining courses is Bachelor of Business Studies (A3), Bachelor of Management Studies (A4), and Bachelor of Commerce (A1). The result of the comparative study showed that the proposed VIKOR method is a viable tool for solving the course selection problem for prospective university students having effectively rank similar course selection problem previously solved by Lokare and Jadhav (2016) who applied the TOPSIS method. The proposed tool will complement the effort in literature in mitigating the challenges faced by prospective university students in their quest to secure successful future careers. The VIKOR and TOPSIS techniques evaluation procedure are quite similar (Mateusz et al., 2018) *as both methods ranking principles are based on an aggregating function representing "closeness to the idea" which originated in the compromise programming method* (Opricovic and Tzeng, 2004). This may be attributed to why both approaches produced the same ranking order of the alternative courses. However, in this study, the VIKOR method is recommended for analysis of the decision problem because it is an improved variant of the TOPSIS method and requires less computational effort (Carpinelli et al., 2014, Ghaleb et al., 2020).

4. CONCLUSION

In this paper, the VIKOR technique is presented for solving course selection problems for prospective university students. A case of a prospective university student faced with the challenge of selecting the best course from among three alternative courses consisting of medicine (A1), engineering (A2), and law (A3) was used to illustrate the suitability of the proposed method. The performance of these three courses was evaluated using four decision criteria: student interest, (C1), employment opportunity (C2), course duration (C3), and tuition fee (C4). The analysis of the decision problem with the VIKOR method indicated that the alternative courses are rank in descending order of A1, A2, and A3. Therefore, the most suitable course for the prospective university student is medicine (A1). To validate the proposed technique, it was used to solve a high school student course selection decision problem previously analysed with the TOPSIS method by Lokare and Jadhav (2016). The comparative study showed that both approaches generated the same result. It can be concluded that the proposed approach is a reliable tool for addressing the problem of course selection for prospective university students.

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6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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